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Does nomenclatural availability of nomina of new species or subspecies require the deposition of vouchers in collections?

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Table of contents

Abstract 1
Introduction 2
Nomenclatural availability of nomina 3
Changes in the *Code* regarding the nomenclatural function of onomatophores 6
Illustrations as onomatophores 9
Arguments for and against basing nomina on virtual or missing specimens 10
Favourable arguments 10
(1) The conservation issue 10
(2) The difficuty or impossibility of collecting or conserving specimens 10
(3) Descriptions based on ancient illustrations 10
Unfavourable arguments 11
(1) Hypothetical concepts 11
(2) Phantom nomina 11
(3) Photographs as scientific evidence 12
(4) Alive specimens as onomatophores 13
(5) The conservation issue 14
Proposals regarding the Rules of nomenclatural availability of nomina 17
Conclusion 19
Acknowledgments 20
References 20

Abstract

Several species of birds and primates recently described opened a debate in the zoological community on the possibility of naming new species or subspecies without material onomatophores ("name-bearing types") deposited in collections. The current writing of the *Code* is ambiguous in this respect. We support here the view that such practice is not doing a service to the discipline of taxonomy as illustrations, DNA sequences or "definitions" cannot replace voucher specimens. The latter are and will be badly needed for the proper knowledge of the vanishing biodiversity of our planet. We review arguments pro and con the need to have a Rule in the *Code* requiring the deposition of onomatophores in collections for the proper and valid creation of new nomina in zoological nomenclature. In conclusion, we propose a more drastic Rule in this respect but also the possibility, in some exceptional cases, to apply to the International Commission on Zoological Nomenclature to make nomina available even in the absence of material onomatophores.

Key words: Biodiversity crisis — Nomenclatural availability — Vouchers — Onomatophores — Collections — Illustrations — DNA sequences — Definitions — *Code* — Commission

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Introduction

This paper discusses an important question of zoological nomenclature at the verge of the "century of extinctions" (Dubois 2003): that of the *nomenclatural availability* and consequently *validity* of zoological scientific names or *nomina* (Dubois 2000) published without *onomatophores* ("type-specimens"; see Dubois 2000, 2005) deposited in a collection. This problem has been raised recently for several species of vertebrates considered "rare and endangered". It is only one avatar of a new tendency in taxonomy, consisting in the description and naming of new taxa without voucher specimens, e.g., based only on molecular evidence, even when no threat on the taxon is currently identified, or of taxa "defined" through "phylogenetic definitions" but without vouchers or even diagnostic characters. Such problems may become more and more common if the strict and clear Rules of the *International Code of Zoological Nomenclature* (Anonymous, 1999; "the *Code*" hereafter) regarding nomen availability are not understood and adopted by all zoologists and scientific editors.

As it develops, the biodiversity crisis — mainly caused by anthropogenic factors — will more and more face zoologists with the ethical dilemma of sacrificing specimens potentially important for the survivorship of their species in order to satisfy the minimum criteria established by the *Code* to make a new nomen available. This situation already exists but will tend to become more frequent in the forthcoming years, as extinctions will go on and as new taxa — especially of vertebrates — will be discovered in isolated refuges, with small relict populations and therefore highly threatened with extinction. Whereas some taxonomists aim to rely on scientific objectivity and precision through the deposition of fixed reference specimens (onomatophores) in public collections, some are also tempted to skip this procedure to give new discovered species with tiny populations a better chance of surviving. However, the *Code* does not provide special conditions for describing "endangered" species, and its Rules for the nomenclatural availability of nomina must be followed if the latter are to be used validly to designate zoological taxa.

This problem concerning onomatophores is but one special example of a more general trend in recent scientific literature dealing with systematics, phylogeny and evolutionary biology, where the important role of vouchers is underestimated, if not ignored or denied (Funk *et al.* 2005). This is illustrated by the fact that some major databases such as Genbank do not require the indication of voucher specimens associated with the information they store (molecular sequences in the case of Genbank). The case of the classical cytological studies in botany reminded by Funk *et al.* (2005: 127) is exemplary of what could be the fate of some of the data in Genbank and other databases: "the absence of vouchers for literally thousands of early chromosome counts — a majority of all counts made prior to 1965 — has rendered those data essentually worthless: the identity of the plants cannot be verified. The enormous effort made by those early cytologists comes to little or nothing at all."

No rules oblige taxonomists to deposit vouchers when they describe a new species, simply because there is no "code of taxonomy" — for reasons detailed by Dubois (2005). However, as soon as not only describing, but also naming is involved — a distinct process, which belongs in nomenclature, not in taxonomy proper —, vouchers are necessary. Although the nomenclatural role of these special vouchers is particular (to provide an objective standard for the allocation of nomina to taxa; see below), these specimens have also "incidentally" an important taxonomic function, that of providing material references for the characters described by taxonomists. Because of this secondary, taxonomic, function of onomatophores, the *Code* so to speak fills a deficiency caused by the absence of a code of taxonomy. Onomatophores are indeed very important vouchers for the whole of evolutionary biology, and museums and other collections caring for their preservation in good conditions play a major role in our understanding of biodiversity.

In the recent years, several zoological species were described as new without deposition of reference specimens in collections, because these species were considered by their discoverers too endangered to allow collection of even a single specimen without increasing their risk of extinction. Examples include the bird *Laniarius liberatus* (Smith *et al.* 1991) and several primates: the mangabey *Lophocebus kipunji* (Jones *et al.*

2005), later made the type of a new genus (Davenport *et al.* 2006); the lemur *Avahi cleesei* (Thalmann & Geissmann 2005); and the capuchin *Cebus queirozi* (Mendes Pontes *et al.* 2006). These cases have been in the center of a contentious debate on the need for keeping dead specimen holotypes for establishing the nomina of new animal species. Whereas some authors (Timm *et al.* 2005, Landry 2005, Oliveira & Langguth 2006) stated that the nomina of these taxa, if published after 1999, are nomenclaturally unavailable, others (Wakeham-Dawson *et al.* 2002, Polaszek *et al.* 2005) defended the opposite idea. Similar situations, although in these cases not caused by threats on the species but on "rarity" of species and difficulties in collecting them, were recently encountered in several cases of descriptions of new species based on DNA sequences only, without onomatophores, for example in whales (Dalebout *et al.* 2004, and references therein), and these cases were also taken as flag examples for a plea for "modern" nomenclature that could supposedly be "freed" from the constraint of depositing dead specimens in collections (Dalebout & Baker 2002): "Due to the declining abundance of many species, access to complete anatomical specimens is becoming a vanishing luxury. (…) For many animal taxa, the lethal collection of such voucher specimens would now also be considered unethical." (Dalebout *et al.* 2004: 459).

Interestingly, this new trend meets another recent one in biological nomenclature, illustrated by the promoters of nomenclatural systems alternative to the current codes, where allocation of nomina to taxa is not based on onomatophores but on so-called "phylogenetic definitions". As discussed in detail elsewhere (Dubois 2005, 2006b), a basic problem (among others) of such nomenclatural systems is that they miss the material connexion between language and specimens realized by onomatophores.

Our aim in this paper is to explore again this question in the light of the current *Code* and of other considerations.

Nomenclatural availability of nomina

Dubois (2005) distinguished three steps in the nomenclatural process required to establish the valid nomen of a taxon in zoology under the Rules of the *Code*: *availability* of nomen (through publication and respect of precise criteria), *allocation* of nomen to taxon (through onomatophore) and *validity* of nomen (through priority). These three "floors of the nomenclatural house" must be explored successively. Regarding the first floor, availability, Dubois (2000) recognized two categories of nomina: *hoplonyms* are nomina published through respect of all *Code*'s criteria of nomen availability, whereas *anoplonyms* are nomina published but not respecting all these criteria, and therefore nomenclaturally unavailable (i.e., "non-existent" in zoological nomenclature). Criteria of availability are mostly described in Chapter 4 (Articles 10 to 20) of the *Code*, but also in Chapter 1 (Articles 1 to 3) of the latter. The term *nomen nudum* (*gymnonym* in Dubois 2000) designates only a subcategory of the category of anoplonym, as the "Glossary" of the *Code* (p. 111) defines it as a nomen "that, if published before 1931, fails to conform to Article 12; or, if published after 1930, fails to conform to Article 13". To be an anoplonym, a nomen just has to fail to conform to any of the Articles 1–3 and 10–20, so this covers a much wider array of cases than the category of *nomen nudum*.

It is important to realize that the Rules for nomen availability have changed through time, and these Rules nowadays are much more stringent than in the past. Today, practising taxonomists are following these Rules, not those of the past. Importantly, Article 16 is new, and it introduces important changes compared to the previous edition of the *Code* (Anonymous 1985). Let us review the Rules of the *Code* regarding nomen availability.

Chapter 1 ("Zoological nomenclature") provides general Rules for admissibility of nomina covered by the *Code*: nomina failing to conform these Rules are therefore anoplonyms. Article 1.1 states that zoological nomenclature only covers nomina applied to taxa of extant or extinct animals, which excludes oganisms referred to other kingdoms. Article 1.3 expressly excludes from zoological nomenclature several categories of

nomina, in particular proposed “for hypothetical concepts” (Art. 1.3.1) or “after 1930, for the work of extant animals” (Art. 1.3.6). The “Glossary” of the *Code* (p. 101) defines “hypothetical concept” as follows: “A taxonomic concept that when published contained no animal then known to exist in nature, past or present, but only in the mind of the author whether a prediction or not”. This sentence is strangely written, as a concept cannot “contain” an animal, but “refer to” or “designate” it. The French version of the “Glossaire” (p. 235) proposes a more accurate definition of “concept hypothétique”, as it mentions that such a concept “n’est pas basé sur un animal (...)” (“is not based on an animal”). Article 3 excludes from zoological nomenclature all nomina and nomenclatural acts published before 1758.

Chapter 4 (“Criteria of availability”) lists all criteria which must be met for a nomen to be available in zoological nomenclature. For the purpose of the present discussion, we will briefly survey most of these conditions and only outline a few of them. Articles 10 and 11 present general conditions of availability, in particular regarding the need of publication and the formation of nomina. Article 12 presents special requirements that only apply to nomina published before 1931: any such nomen “must be accompanied by a description or a definition of the taxon that it denotes, or by an indication” (Art. 12.1), and Art. 12.2 defines precisely the meaning of the term “indication”. Article 13 concerns nomina published after 1930, and requires that they “be accompanied by a description or definition that states in words characters that are purported to differentiate the taxon”, or refers to such a published statement, or be proposed as a *nomen novum* (*neonym* in Dubois 2000) for an already available nomen. Article 14 excludes from zoological nomenclature nomina published anonymously before 1950, and Article 15 excludes nomina published conditionally, or for taxa given the ranks “variety” or “form”, after 1960. Articles 17 to 20 provide special Rules concerning availability of nomina in a few particular situations (e.g., nomina applied to taxa of hybrid origin, tautonymous nomina or subsequent spellings of nomina).

All the preceding articles existed, in similar or slightly different forms, in the past editions of the *Code* until the so-called third one (Anonymous 1985), and none of them mentioned the need, for availability of nomina, of the existence of an onomatophore (holotype, syntypes, lectotype or neotype). However, an important change was brought to the *Code* in Article 16 of the fourth edition (Anonymous 1999), which added several requirements for availability of nomina published after 1999. These new requirements include the need of an explicit statement of the intention to establish a new nominal taxon, the need to mention the type genus of a new familial nomen, and, above all, the need of fixation of the onomatophore for any new specific or subspecific nomen. As this part of Article 16 will be in the center of the discussion below, it is better to provide a large quote of it, including some of its Recommendations:

“16.2. **Family-group names: type genus to be cited.** (...) a new family-group name published after 1999 must be accompanied by citation of the name of the type genus (...).

16.4 **Species-group names: fixation of name-bearing types to be explicit.** Every new specific and subspecific name published after 1999, except a new replacement name (a nomen novum), for which the name-bearing type of the nominal taxon it denotes is fixed automatically (...), must be accompanied in the original publication

16.4.1. by the explicit fixation of a holotype, or syntypes, for the nominal taxon (...), and,

16.4.2 where the holotype or syntypes are extant specimens, by a statement of intent that they will be (or are) deposited in a collection and a statement indicating the name and location of that collection (see Recommendation 16C).

Recommendation 16C. Preservation and deposition of type specimens. Recognizing that name-bearing types are international standards of reference (see Article 72.10) authors should deposit type specimens in an institution that maintains a research collection, with proper facilities for preserving them and making them accessible for study (i.e. one which meets the criteria in Recommendation 72F).

Recommendation 16D. Publication of information distinguishing type specimens. When providing information to distinguish the type specimen(s) from other specimens (Article 16.4.1) authors should include

information such as specimen numbers and descriptions of labels (see Recommendations 73C and 73D for data recommended).

Recommendation 16E. Preference for holotype over syntypes. Whenever possible, authors should select a holotype rather than syntypes.

Recommendation 16F. Illustrations of type specimens. Whenever possible a holotype or syntypes should be illustrated, showing characteristic features of the taxon, in the work in which the new nominal taxon is established."

Also relevant for this discussion are the following Articles:

"72.2. **Fixation of name-bearing types from type series of nominal species-group taxa established before 2000.** A nominal species-group taxon established before 2000 may have its name-bearing type fixed from the type series (...) originally (...), or subsequently (...). (If no name-bearing type is believed to be extant a neotype may be fixed; see Article 75 for conditions).

72.3. **Name-bearing types must be fixed originally for nominal species-group taxa established after 1999.** A proposal of a new species-group taxon after 1999 (unless denoted by a new replacement name (nomen novum) (…), must include the fixation of a holotype (...) or syntypes (...). In the case of syntypes, only those specimens expressly indicated by the author to be those upon which the new taxon was based are fixed as syntypes.

(...)

72.5. **Eligibility as name-bearing types.** Only the following are eligible to be a name-bearing type, or part of a name-bearing type, or a nominal species-group taxon:

72.5.1. an animal, or any part of an animal, (...);

72.5.6. In the case if a nominal species-group taxon based on an illustration or description, or on a bibliographic reference to an illustration or description, the name-bearing type is the specimen or the specimens illustrated or described (and not the illustration or description itself).

(...)

72.10. **Value of name-bearing types.** Holotypes, syntypes, lectotypes and neotypes are the bearers of the scientific names of all nominal species-group taxa (and indirectly of all animal taxa). They are the international standards of reference that provide objectivity in zoological nomenclature and must be cared for as such (...). They are to be held in trust for science by the persons responsible for their sage keeping.

Recommendation 72D. Labelling of name-bearing types. Holotypes, syntypes, lectotypes and neotypes should be labelled in a way that will unmistakably denote their status.

Recommendation 72E. Publication of information on labels. An author who designates a holotype, lectotype, neotype or syntypes should publish all information that appears on the labels accompanying the specimens so as to facilitate the future recognition of the specimens.

Recommendation 72F. Institutional responsibility. Every institution in which name-bearing types are deposited should

72F.1 ensure that all are clearly marked so that they will be unmistakably recognized as name-bearing types;

72F.2 take all necessary steps for their safe preservation;

72F.3 make them accessible for study;

72F.4 publish lists of name-bearing types in its possession or custody; and

72F.5 so far as possible, communicate information concerning name-bearing types when requested.

(...)

73.1. **Holotypes.** A holotype is the single specimen upon which a new nominal species-group taxon is based in the original publication (...).

73.1.1. If an author when establishing a new nominal species-group taxon states in the original publication that one specimen, and only one, is the holotype, or 'the type', or uses some equivalent expression, that

specimen is the holotype fixed by original designation. (...)

73.1.4. Designation of an illustration of a single specimen as a holotype is to be treated as designation of the specimen illustrated; the fact that the specimen no longer exists or cannot be traced does not of itself invalidate the designation. (...)

Recommendation 73C. Data on the holotype. An author who establishes a new nominal species-group taxon should publish at least the following data concerning the holotype, if they are relevant and known to the author: (...)

73C.6 the collection in which it is situated and any collection number or register number assigned to it; (...)"

Changes in the *Code* regarding the nomenclatural function of onomatophores

Before discussing the problem addressed by the papers mentioned above, it is useful to clarify the nomenclatural function of onomatophores ("name-bearing types"). One often reads that these specimens "provide objectivity in zoological nomenclature" (e.g., Art. 72.10 of the *Code* quoted above). This is true, but needs more precise qualification. The function of these specimens is not, as some have construed it (e.g., de Queiroz & Gauthier 1990, 1994; Pennisi 2001; Joyce *et al.* 2004; Sluys *et al.* 2004), to provide *characters* that would allow to *define* the taxon to which the nomen is applied: this would rely on a typological conception of taxonomy which is outdated and that few recent taxonomists would support (Dubois 2005). The definition of taxa is not a matter of nomenclature but a matter of taxonomy, and the *Code* does not deal with taxonomy but with nomenclature. The *Code* does not provide rules or guidelines for defining taxa, but Rules for naming taxa once they have been defined. To avoid such basic confusion, extirpation of the term "type" of its derivatives from the vocabulary of nomenclature would be useful (Dubois 2005) and this is why we here use the term *onomatophore* (Simpson 1940) for "name-bearing type" in the *Code*.

The main role of onomatophores under the *Code* is to provide an objective connexion between the world of specimens (and, through them, of natural populations of organisms) and the world of language (Dubois & Ohler 1997a–b). It allows allocation of a nomen to a taxon or several taxa. A given nomen applies potentially to any taxon that includes its onomatophore — in fact, it only applies to a single taxon or a few taxa, because of the existence of several nominal-series and of the Rule of Coordination (for details see Dubois 2006b and submitted-a) — and that is all. This function of onomatophore (bearing the nomen) pertains in the second floor of the nomenclatural house (nomen allocation) and has nothing to do with availability of nomen. Until 1999, no Rule existed requiring the designation of an onomatophore for availability of a nomen, and Rules allowed subsequent fixation of onomatophores for nominal-taxa first created without onomatophores (at least in the species and genus nominal-series). The 1999 edition of the *Code* introduced a new function for onomatophores, in requiring their designation for a nomen to become available. This is an important change, highly welcomed by taxonomists (see below), but which does not imply that onomatophores, as such, are used to provide the characters of the taxa denoted by the nomina. "As such" means that, beside their nomenclatural function of onomatophores, the same specimens, which are part of what the *Code* calls the series of "type specimens", but which is better designated as the *hypodigm* (Simpson 1940, Dubois 2006a), also have a taxonomic function, which is to provide characters that will be used to build up a taxonomy (nowadays often through the formulation of a phylogenetic hypothesis).

In the 1985 *Code*, explicit designation of an onomatophore was compulsory for nomen availability only for nomina of the genus-series, as Article 13.b required that such a nomen created after 1930 "be accompanied by the fixation of a type species". The 1999 *Code* is much more consistent in this respect, as its Article 16.2 requires that new family-series nomina created after 1999 "be accompanied by citation of the name of the type genus", and its Article 16.4 provides a similar Rule for species-series nomina (see below). Such Rules are

consistent and most welcome, because they clearly point to the Principle of Onomatophores as the basic principle for allocation of nomina to taxa in the *Code*. This is a major difference with other nomenclatural systems like those supported by proponents of various systems of "phylogenetic nomenclature", and this is the main reason why both kinds of nomenclatural systems are incompatible and cannot be "reconciled" or "mixed" as suggested by some (e.g., Kuntner & Agnarsson 2006). This is also the major reason for superiority of the *Code* over these alternative systems, as it maintains a permanent link between specimens and nomina and is therefore not an internal system within language, and as it allows nomenclature to remain theory-free regarding taxonomy, and therefore liable to adapt to new taxonomic paradigms that might develop in the future (Dubois 2005 and submitted-a).

For the availability of nomina, the last edition of the *Code* now requires "fixation" of onomatophores. "Fixation" means that, to be available, a new nomen must have been created *associated with the fixation or designation* of a holotype or syntypes. By itself, this statement simply requires this *designation*, but not clearly that the onomatophore be *preserved* after designation and description, as will be discussed below.

Why was this important change brought to the *Code*? No explanation was provided in this respect in the "Introduction" of this edition (Ride 1999), although this text spent space tackling other minor questions or points that were not yet in order at the time of its publication (such as the eventuality of "replacing 'publication' as a primary determinant of availability", a very questionable idea indeed). We can see two immediate reasons for supporting this major change: (1) requiring the designation of onomatophores avoids the introduction into nomenclature of nomina based on "hypothetical concepts", as defined above; (2) it avoids the creation of "phantom nomina", as defined by Vences *et al.* (1999). These points will be further clarified and discussed below, but it should be clear already that, if these two reasons are indeed behind the change in this article of the *Code*, simple consistency would require that onomatophores be not only designated but also preserved, as otherwise none of these two problems would be solved.

As a matter if fact, there is an apparent contradiction between Articles 16.4.1 and 16.4.2 of the new *Code*. Article 16.4.1 requires the *explicit fixation* of an onomatophore for any new species-series nomen to be available. A common sense interpretation of this Rule is that this fixation of the onomatophore must always be followed by its deposition in a public collection, all the more that Article 72.10 states that such specimens are "international standards of reference" that "are to be held in trust for science". This would mean that nomina created on the basis of an illustration, without real specimen, would be anoplonyms if published after 1999. However, this interpretation is not straightforward. Article 16.4.2 starts with the words "where the holotype or syntypes are extant specimens" — which means that they may *not* be extant specimens, and therefore may *not* be deposited in a collection. Polaszek *et al.* (2005: 2165) recognized that the current wording of Article 16 of the *Code* is ambiguous and should be made clearer, since they wrote: "The well-intentioned reactions of Landry and Timm et al. show that the current Code is open to different interpretations on the subject of type specimens". What can be these "different interpretations"?

According e.g. to the *Oxford Dictionary* (Thompson 1995: 476) "extant" means "still existing", and the "Glossary" of the *Code* (p. 104) also defines it as "still in existence". The first part of Art. 16.4.2 thus suggests that the holotype or syntypes may not be still in existence without impeding nomenclatural availability. There seems to be three possible reasons why it could not be the case: (R1) the specimen was examined by the describer, then killed, fixed and deposited in a collection, but later destroyed, lost or misplaced, so that it had disappeared at the time of publishing the description; (R2) it was examined alive by the describer, but then escaped or was set free before publication of the description; (R3) it was described only from indirect evidence (drawing, photograph, description, traces, etc.), but it has never been in the hands of the describer. The first case (R1) must be extremely rare in the case of nomina created after 1999, as it is unlikely that a specimen was killed, deposited in a collection, and destroyed or lost just after, before publication of the description, in a period of a few years. In contrast, both the second and third possibilities may apply to nomina created after 1999 and covered by Article 16.4.2 if the current *Code*.

Polaszek *et al.* (2005) and others interpreted this article as meaning that a species can be named without depositing an onomatophore in a collection. This interpretation (I1) is supported by Article 73.1.4, which states that, even after 1999 (as no mention of a limiting date is made in this article), an illustration may be designated as onomatophore of a new taxon, and that "the fact that the specimen no longer exists or cannot be traced does not of itself invalidate the designation". With this interpretation, the mention of the possibility to create a new nomen without "extant specimen" almost amounts to a return to the situation before 1999 and largely nullifies the progress introduced in the *Code* by Article 16.4.1. It still allows nomina to be created entirely within language, without objective reference to specimens, and is therefore a half-way measure which seems questionable. Under this interpretation, the post-1999 nomina mentioned above (*Lophocebus kipunji*, *Avahi cleesei* and *Cebus queirozi*) are hoplonyms (nomenclaturally available).

However, another interpretation (I2) of this article is possible. Under this reading, the case (R3) above would be acceptable, but not the case (R2). In the latter situation, the species was described on the basis of a living, therefore then "extant" specimen, and Article 16.4.2 would therefore require its deposition in a collection, or statement of intent of such a deposition. Under such an interpretation, it is not acceptable to release this specimen free, as this would contravene the dispositions of this article. Therefore, description of a new species based on a living specimen would allow availability of nomen only if the specimen is, or will later be, deposited in a collection. Under this reading of the *Code*, the latter would give no license to release a holotype after capture, description, photograph and possibly taking off a sample of blood, feather or hair for DNA analysis. If this is accepted, the three nomina listed above (and others in the same situation) are anoplonyms (nomenclaturally unavailable).

As recognized by Polaszek *et al.* (2005), the current writing of Article 16 does not allow by itself to choose between these two interpretations. The choice by Wakeham-Dawson *et al.* (2002) and Polaszek *et al.* (2005) of interpretation (I1) seems to be based on two widely different elements. The first one is Article 73.1.4, which, as mentioned above, allows designation of a figured specimen as onomatophore without limiting date (i.e., even after 1999). If interpretation (I2) was considered valid, then Articles 16 and 73 would be in contradiction. The second element is the fact that interpretation (I1) is supported by current and past members of the International Commission on Zoological Nomenclature ("the Commission" hereafter), including its current (Andrew Polaszek) and preceding (Philip Tubbs) Secretaries, so it would seem to correspond to the "intention" of the authors of the current edition of the *Code*, who did not wish to make deposition of a holotype in a collection compulsory for nomen availability. However, when "juridical" texts like the *Code* are concerned, the intention of the draftsmen is of little importance, what counts is the final text. The current text being ambiguous, it should be clarified in the next edition of the *Code* by adding some precisions. It can be so in two different directions.

If the aim is to support interpretation (I1) above, a single change is required: (C1) a second part should be added at the end of Article 16.4.1, stating that "this or these specimen(s) may be extant or not".

If the aim is to support interpretation (I2) above, three changes should be brought to the present *Code*: (C2) Article 16.4.1 should be written as follows (or an equivalent writing): "by the explicit fixation of one or several extant specimen(s) as holotype or syntypes ..."; (C3) the first 8 words of Article 16.4.2 should be suppressed and this article should start with "by a statement..."; (C4) Article 73.1.4 should start with the words (or equivalent): "For nominal taxa created before 2000".

Until changes are brought to the current writing of the *Code* in either of these two directions, the ambiguity described above will remain, but as the current officers of the Commission are not in favour of forbidding description of a new species without an onomatophore, they are likely to "impose" their interpretation to the international community of taxonomists. Under this interpretation, there is no contradiction between Articles 16 and 73, whereas under the interpretation (I2) these two articles are not consistent, and one of them, at least, should be changed.

Thus, under interpretation (I1), favored by the Commission, the current *Code* allows to create a new

nomen without an extant specimen, especially if an illustration of this specimen exists. Is such a Rule indeed appropriate? Let us explore this question in more detail.

Illustrations as onomatophores

In botanical nomenclature (McNeill *et al.* 2006), the onomatophore of a specific or infraspecific nomen can be either a specimen or an illustration (Art. 8.1). In the latter case, the botanical code makes it quite clear that the onomatophore is the illustration, not the specimen shown by the latter, although it is recommended to go back to material specimens for nomen allocation: "When a holotype, a lectotype, or a neotype is an illustration, the specimen or specimens upon which that illustration is based should be used to help determine the application of the name" (Art. 8.1). Such Rules have an important consequence: as the illustration itself is the onomatophore, the fact that the specimen on which the illustration was based is now lost does not allow to designate a neotype for the taxon.

The situation is different in zoology. According to the Rules of the current *Code*, the status of illustrations as basis for the creation of new zoological nomina depends on the date of publication. For nomina published before 1931, one possible "indication" that can be used to make them available is defined as follows in Article 12.2.7: "the proposal of a new genus-group name or of a new species-group name in association with an illustration of the taxon being named, or with a bibliographic reference to such an illustration". Therefore, before 1931, a new nomen could be created even without a verbal description or definition of the taxon for which it was intended. This is no more possible after 1930, as after that year Article 13.1.1 requires that a nomen "be accompanied by a description or definition". However, in this article it is not stated that an author must have had a specimen in the hands to write a description or indication, and the latter may well have been prepared on the basis of an illustration. The new Article 16 does not suppress this possibility. It just requires an explicit fixation of an onomatophore, but not clearly that this specimen be "an extant specimen". This is further confirmed in Article 73.1.4 copied above.

There is a basic difference between the botanical and zoological codes as concerns the status of illustrations as onomatophores. In contrast with the botanical code, the zoological code makes it clear that the onomatophore is the specimen(s) figured, not the illustration itself. This has an important consequence regarding the situation, which is rather common when old illustrations are concerned, where the specimen(s) used as a basis for the illustration is/are now lost or destroyed. In such a case, the onomatophore is no longer extant, which opens the possibility to designate a neotype for the taxon if the conditions of Article 75.1 are met, i.e., when "an author considers that a name-bearing type is necessary to define the nominal taxon objectively". This is a very useful particularity of the *Code*. In particular, it allows to settle at best the nomenclatural status of nomina created in old works on the basis of syntypes consisting in several specimens and/or illustrations, especially when these were of different origins and likely to belong in different taxa. One possible procedure in such cases, used e.g. by Kottelat & Lim (1993), Dubois & Ohler (1995) and Kottelat & Persat (2005), and illustrated and explained in detail in Dubois & Ohler (1997a–b), is to solve the ambiguity attached to the nomen by a nomenclatural action involving two distinct steps: first, to designate as lectotype one of the specimens figured, which can allow for example to restrict the type-locality of the taxon and to eliminate the other syntypes from the onomatophore; and then, taking advantage of the fact that this specimen is no more extant, to designate a neotype from the same locality.

So, despite its new Article 16.4.1, the current *Code* still apparently leaves open the possibility to create a new nomen on the basis of an onomatophore shown in an illustration but not available nowadays for study, i.e., a virtual or missing specimen. Clearly, some authors are in favour of this system, and others not. Let us consider the pros and cons of this system.

Arguments for and against basing nomina on virtual or missing specimens

Favourable arguments

(1) The conservation issue

The first argument in favour of accepting availability of nomina even in the absence of extant onomatophore deposited in collections is of course the "conservation" one. It does not seem adequate to collect and kill even a single specimen of a species that, at the very moment of its discovery, appears to be on the verge of extinction. This reason was given by the authors of the primate and bird nomina mentioned above to describe these species without material onomatophores.

This argument in fact contains two different aspects. The first one is that it is genuinely believed by these biologists that capturing and fixing even a single specimen of such species may indeed have a major impact on the survival of the latter. This will be further discussed below. The second one is in fact quite distinct: it is that killing a specimen of such an endangered species would certainly not be understood by conservationists and more largely by "the public". Such a behaviour would appear "irresponsible" to these people, and, above all, would contribute to give a bad image of taxonomists to outsiders of the discipline of taxonomy. As the latter is already poorly understood and appreciated among biological sciences, and, by way of consequence, severely underfunded and much too short in professional positions (Dubois 2003, Wheeler *et al.* 2004), any action that might contribute to undermine its image should be avoided by all means. Although they rarely state it clearly, this second motivation might be more important than the first one for taxonomists who decide to describe new species without fixed specimens.

(2) The difficuty or impossibility of collecting or conserving specimens

Some material reasons may make it very difficult or virtually impossible to collect or preserve specimens of a new species. This is in particular the case of some marine organisms, especially of very large size (such as some cephalopods or cetaceans) or living in deep habitats. Some of these organisms may be observed and photographed, e.g. from a deep-sea submersible, but not collected. Should taxonomy be deprived from dealing with such organisms because taxonomists cannot have them in the hands? In such cases, it could appear that naming such taxa on the basis of photographs alone is justified. This point will be discussed further below.

A related case would be that of organisms which for some reason, after collection, cannot be conserved in such a way as to allow their subsequent study. However, this case seems to be mostly a theoretical possibility as, although some organisms are more difficult than others to fix and conserve properly, it is usually possible to find appropriate, even if unusual, modes of conservation for them.

(3) Descriptions based on ancient illustrations

This case might be the most convincing one for the formal description of species without having actual specimens in hands. Ancient iconographic documents are sometimes used by some taxonomists to provide evidence that the specimens which were used to produce these illustrations belonged indeed in unknown, or at least undescribed and unnamed, zoological species. This may even in some extreme cases be possible using solely descriptions in words, without illustrations, when these descriptions are detailed enough, and apparently accurate enough, to warrant such conclusions.

A good example of this situation is the formal description and naming by Bour (1978) of a new tortoise from the Mascarene, based on illustrations published in 1737 that were precise enough to allow ascertaining the diagnostic characters of this species, which had become extinct around 1840 as a result of man's exploitation (Bour 1984), and which was until then known only by imprecise descriptions of travellers. Interestingly, this description prompted the discovery of subfossil remains of the same species, which allowed a more com-

plete redescription (Bour 1979), and later to show that this species was in fact the one that had been originally named *Testudo indica* Schneider, 1783 on the basis of a holotype, still extant, but which had been considered for two centuries of unknown origin (Arnold 1979, Austin *et al.* 2002). Such exceptional discoveries will no doubt remain possible in the future, and it certainly would not be appropriate to forbid the naming of such species because no specimen is available.

Unfavourable arguments

(1) Hypothetical concepts

The *Code* expressly excludes from its domain nomina proposed for animals not known with certainty to exist or to have existed in nature, "but only in the mind of the author whether a prediction or not". This definition may seem clear, but needs further information to become operational. The only way to be sure that an animal does not exist only in the mind of a person is to be able to examine a specimen. Such nomina can well be "defined", even "phylogenetically", but they may not correspond to any organism in the real world. A striking example is provided in a paper where many hypothetical groups of amphibians were defined (Lescure *et al.* 1986), based on phylogenetic hypotheses that were not supported by subsequent works (Nussbaum & Wilkinson 1989), so that these taxa fully correspond to the notion of "hypothetical concept" as defined in the *Code*.

As discussed below, a photograph by itself cannot be used as an objective proof of the existence of an animal, and a verbal description or a testimony, even if supported by several witnesses, cannot qualify as a scientific evidence, for several reasons spanning from observations that are inaccurate (although honest) due to various material reasons, to deliberate falsification or pure invention. Good examples of such problems are those posed by the various "mythical animals" that have been "seen", sometimes by many "witnesses", but for which material evidence is still missing, such as the abominable snowman and its avatars (yeti, migu, barmanu, sasquatch, etc.), the Loch Ness monster and various "sea snakes" and other marine monsters. Most of these stories are purely verbal, but some "material documents" indeed exist, such as "photos" of the Loch Ness monster or of the sasquatch, or recordings of the voice of the Caucasian barmanu, which all have in comment to be of "bad quality" (photos out of focus, recordings with noisy background, etc.).

In a few cases, Latin nomina were indeed proposed for such "animals", despite the absence of specimens, but on the basis of testimonies, descriptions, traces such as footprints, hair or "scalp", or even photographs. An interesting case is that of the "iceman" formally described and named *Homo pongoides* on the basis of a specimen purported to have been examined through ice in an itinerant circus, but which later "disappeared", and for which several photographs and drawings were published (Heuvelmans 1969, Heuvelmans & Porchnev 1974). What can science do with such "descriptions" and nomina? How can the criterion of Article 1.3.1 for exclusion of "hypothetical concepts" be applied? Is the nomen *Homo pongoides* a hoplonym or an anoplonym, and, if it is a hoplonym, what is its status? Valid nomen, synonym, *nomen dubium*? If deposition of a specimen in a public collection was compulsory for availability of new nomina, such a question would not be raised, and formal description would have to await capture of a specimen or discovery of remains attributed to this "taxon".

(2) Phantom nomina

This concept was coined by Vences *et al.* (1999) for new nomina "accidentally" published without proper descriptions and identified vouchers in amateur publications or animal shop catalogues dealing with animal groups that attract many hobbyists (in their case brightly colored frogs of the genus *Mantella* Boulenger, 1882), on the basis of photographs of live specimens later sold to customers. These authors discussed the major problems posed by the proper allocation of such nomina to taxa, then wrote: "editors of hobbyist journals should not permit their authors usage of new scientific names to name undescribed or undetermined mor-

phs unless the names are accompanied by a formal description and type specimens are deposited in a publicly available scientific collection" (Vences *et al.* 1999: 56). For many taxonomists who work on such "attractive" animal groups (e.g., insects, molluscs or vertebrates kept alive by aquariophilists and terrariophilists), the new edition of the *Code* was received with relief, as the common sense interpretation of the new Rule of Article 16.4.1 is that it now imposes the deposition of onomatophores in public collections for new nomina to be nomenclaturally available. But as this interpretation is not supported by Articles 16.4.2 and 72.5.6, nor by officers of the Commission, taxonomists working on such groups should remain vigilant and expect new problems similar to those described by Vences *et al.* (1999).

(3) Photographs as scientific evidence

There is a widespread but unfounded belief that photographs are "better scientific evidence" than mere written descriptions or even drawings or paintings. There are several reasons why this belief is unfounded. First, photographs have always been liable to be falsified, and faked photographs have indeed been used in many occasions, from political propaganda to commercial or juridical affairs, including science. A recent example in zootaxonomy concerns the new species of coelacanth from Indonesia described as *Latimeria menadoensis* (Pouyaud *et al.* 1999), but for which shortly after a faked photograph was submitted for intended publication in *Nature* (McCabe & Wright 2000). Nowadays, with digital photographs, faking has become even easier and virtually undetectable, and photographs should not be considered reliable proofs by themselves for anything. Faking is also possible with specimens, of course, but such falsifications, whether simple hoaxes or intended to promote particular ideas or to support a personal's carrier, are usually discovered later on by careful examination of the material, as was the case, e.g., for the "Piltdown man" (Weiner *et al.* 1953), but such deceptions may be more difficult to demonstrate with digital photographs.

But faking is not the only reason why photographs are not the best way to know the characters of biological species. Characters are not "facts" that would not depend on the subjectivity of observers. They are interpretations of reality, usually based on a given "reading" by man of the phenotypes of organisms. They depend on scientific judgements and decisions concerning homology, similarity and difference. In this respect, descriptions using words, or scientific drawings, are more informative, because they highlight some features and ignore others, that are considered of no or little relevance for the characterisation of a taxon. In contrast, the implacable objectivity of photographs, which capture in the same manner basic and "meaningless" characters of the specimens, or even sometimes artificial details such as shadows and lights — except, once again, if photographs are modified to show special features, but then we come back to the problem above —, does not provide as much help to taxonomists.

Even with the best goodwill, study of photographs for taxonomic work implies the risk of misinterpreting some characters, of missing others, and sometimes of "inventing" still others. An enlightening example of the latter situation is provided by the recent decription of the new taxon *Torquerator bullocki* (Holland *et al.* 2005). This organism belongs in a group of deep-sea hemichordates that were known from photographs but had not been previously collected. On the basis of the interpretation of the photographs taken by submersibles, where these worms appeared to have collar tentacles, these organisms had been considered a missing link (the so-called "lophenteropneusts") between two main hemichordate body plans, the enteropneusts and the pterobranchs (Lemche *et al.* 1976), and this in turn had influenced ideas about the origin of vertebrates. Collection and study of a specimen of this group showed that these interpretations were wrong: "The collar, although disproportionately broad, lacks tentacles. In addition, we find no evidence of tentacles in the available deep-sea photographs (published and unpublished) of broad-collared enteropneusts, including those formerly designated as lophenteropneusts. Thus, the lophenteropneust hypothesis was based on misinterpretation of deep-sea photographs of low quality and should no longer be used to support the idea that the enteropneust body plan is basal within the phylum Hemichordata." (Hammond *et al.* 2005: 374). In this case, it is therefore fortunate that Lemche *et al.* (1976) were prudent enough not to publish a formal description and naming of these organ-

isms on the basis of photographs alone, as the Latin nomina that could have been created for this purpose would have turned out to be anoplonyms, being based in fact on "hypothetical concepts". In fact and more exactly, they wrote that the nomen Lophenteropneust was "intended to cover a group above the family level and thus no subject to the rules of nomenclature" (Lemche *et al.* 1976: 292), so that if in the future class-series nomina are incorporated into the *Code* (Dubois 2006a) the status of this nomen will have to be settled.

There is no need to turn to deep-sea organisms to encounter problems with descriptions of new taxa based only on photographs. Examples of such problems, discussed by Pauwels & Meirte (1996) and Pauwels & Chérot (1997), include the description of the "Loch Ness monster" as *Nessiteras rhombopteryx* by Scott & Rines (1975), that of *Cryptophidion annamense* by Wallach & Jones (1992) and that of *Cadborosaurus willsi* by Bousfield & Leblond (1995). These cases, and several other ones, belong in the domain of "cryptozoology", a pseudo-science created by Bernard Heuvelmans on the basis of a misunderstanding, because he thought that onomatophores were required by the *Code* for description of new zoological taxa (Pauwels & Chérot 1997): in fact, they were not then, but the problems created by such descriptions led many zoologists to hope that the fourth edition of the *Code* would require the designation of an onomatophore and its deposition in a collection for nomen availability. In the absence of such a Rule, it is formally impossible to exclude from zoological nomenclature some extreme cases of "hypothetical concepts" described as new taxa. Thus, the description by Quintart (1989), as *Marsupilami franquini*, of the marsupilami, an imaginary animal created in cartoons by Franquin, was recorded in the *Zoological Record*, and there is no reason why the Rhinogradentia, imaginary organisms described with extravagant details by an imaginary professor (Stümpke 1962), should not be so!

(4) Alive specimens as onomatophores

In the recent years, some new species were described with live holotypes, maintained in captivity in zoos or vivaria. Although zoological gardens can be considered as a special kind of "collections", keeping live instead of dead animals, their status is quite distinct from collections of museums, for several reasons. First, as long as it is alive, a specimen may escape and disappear forever. It may also die, and its death may not be noticed immediately by the responsibles of its keeping: it may then be eaten, entirely or partly, by other captive animals, including "preys" provided for its feeding (crickets will rapidly eat a frog specimen after its death in a vivarium), it may desiccate or putrefy, etc. Even if found rapidly, in many cases, such a holotype will often not be as well fixed as a specimen killed and fixed carefully for proper subsequent study. Thus, even if the "intention" to fix and keep the specimen in a museum collection after its death is announced, for example in giving it already a collection number even before its death (e.g., the holotype of *Varanus melinus*, see Böhme & Ziegler 1997), this intention may not be fulfilled later on.

What can be the reasons for keeping a holotype alive instead of killing it before description of the new taxon? One of them may be to obtain its reproduction in captivity, which may be all the more desirable as the species is rare and endangered. This can be a good reason only in some cases: specimens of both sexes must be available (in taxa with separate sexes), and breeding must be feasible in captivity. These conditions are not always met, far from that. Other reasons may be to do ethological observations on this specimen in captivity, or simply to show the animal to the public (which is usually the case in zoos). No need to say, in many cases (e.g., in mammals and birds), behaviour in captivity is widely different from behaviour in the field, and the information that will be so obtained will be of little help to know the species better. The question should therefore be asked in all such cases: is the potential benefit that can be derived from keeping the specimen alive worthy of talking the risk to see this specimen escape, or be eaten or injuried by others, or desiccated or rotten, instead of having a well-fixed holotype in a nice position allowing good morphological studies? In many cases, the answer to this question will be "no". But then we come to another problem, the real "mawkishness" of many zoologists nowadays, which results in a number of them been simply reluctant to kill animals, for so-called reasons of "ethics". This problem is explored further below.

(5) The conservation issue

Let us come back here to the conservation issue, in a different perspective from that presented above. If a species is found so critically threatened by extinction that the collection of a single individual would be a risk, then it is quite possible, not to say very likely, that this species will not survive long in nature due to obvious reasons of population dynamics and genetics. In this situation, what is ethical? To allow the species become extinct without documenting the loss? On the contrary, isn't it then an ethical responsibility of zoologists to keep at least one specimen in a museum to document the existence of a species which became extinct during modern times, in most cases as a result of human action? From a scientific point of view, this course, documenting the biological information on diversity, is certainly preferable to that consisting in leaving this species become extinct without keeping a single material testimony of its existence for future generations of biologists. Then, if a species is threatened by extinction, it is *an additional argument* to keep a specimen in a museum, not to the contrary.

It is quite likely that "extreme conservationists", and even perhaps most "conservationists", will not agree with the statement above. They will probably say that, as long as a species has "a chance" to survive, it should be left this chance. Some of them would certainly even push this argument further, and suggest that, even when only one specimen of an undescribed species remains alive, and has no possibility to leave an offspring, it should be left alone, free and untouched — whereas a responsible taxonomist would certainly think that this specimen should be either immediately killed and fixed, or kept carefully in captivity for preservation at its death. We are in fact here in front of *genuinely different* approaches to species extinctions on our planet. Many conservationists think that conservation should be the first priority in all cases, even when the chances of recovery of the species are very weak or null, and even when this attitude threatens the possible obtention of basic biological information on this species. In contrast, many taxonomists will think that preserving at least one specimen in order to preserve *information* for science, should be the priority in such situations. Both points of view have supporting arguments, and there is not "one truth" in this respect. What will be decisive in the end is the relative social influence of the supporters of each approach. In this respect, it is clear that nowadays conservationists have built up strong social lobbies to support their ideas, which is not the case of zootaxonomists — who have shown until now very little aptitude for social communication and power (Dubois 2003) and who have not even proved able to create an international scientific society, not to mention a lobby (Dubois 2006c). But this does not demonstrate in the least that the former are "right" and the second "wrong" — only that the former are socially more efficient (which is widely different, and illustrated by many recent decisions of "policy makers" in science, a matter which is far beyond the scope of the present paper). At any rate, taxonomists should feel free to consider both options, and to do what they think is best, not what members of another community think is best in order to please so-called "social demand", which is in fact merely the demand of one social group, not of society as a whole.

As a matter of fact, the question may be asked whether the "message" that conservationists (at least those who fight against the collection of specimens to document the diversity of life on this planet) want to pass to "society" is the good one. This message is as follows: yes indeed, for centuries, and especially in the last decades, human societies have made "choices" (sometimes without realizing that they were doing so) that had major negative impacts on the ecological equilibria of the planet we live on, and in particular they have been (and still will be) responsible for innumerable species extinctions; however, some of their members at least have now become conscious of this problem, and have decided to do everything possible to stop this process. These persons think that the major priority of the next decade should be to "stop the erosion of biodiversity". Until this point, this message is likely to be agreed upon by most biodiversity-oriented biologists, including conservationists and taxonomists. But consensus is absent when it comes to two further statements: (1) collection of specimens by taxonomists and for museums is a major factor of species extinctions; (2) we have the power to "repair" the destructions that our civilization has done. Let us consider these two statements.

As oultined by Patterson (2002), not a single case is known where *scientific* collecting has imperiled or

caused the extinction of any Neotropical mammal, and we do not know of a single case in any other zoological group. In a few cases of species with commercial value, either as brightly colored, spectacular pets (especially in vertebrates), or as "rare" and very appreciated collection items (especially in insects and molluscs), massive collection may have contributed to deplete or even wipe out some populations or species, but this has nothing to do with taxonomic research and museum collections. Even when taxonomists collect what they consider to be "large series" of specimens (quite useful for the appreciation of intra- and interpopulational variation, and therefore for the characterisation of specific and subspecific taxa), such series are ridiculously small compared with the captures made for human consumption, by pet trade or by insect or mollusc collectors. It is hypocrit, misleading and ill-directed to confound both activities.

Taxonomists, who are an infime minority with a very little power, cannot be the scapegoat for all the mistakes and crimes made by our societies in the last century. It may be appealing to throw back all responsibilities on this small and weak community, but it does not solve anything. Furthermore, even if this is not appreciated by many, practising field taxonomists are in fact among the persons who have the best knowledge of real biodiversity in the wild, and their daily experience is that extinctions are going on at a very rapid pace, in many habitats but mostly in tropical areas, as a result of factors such as deforestation, destruction of humid zones, pollutions of all kinds, climate changes, faunistic and genetic pollution (Dubois 2006c), etc. Most of these destructions are of such a magnitude, and show no significant trend of change (despite repeated declarations and statements), that it is completely misleading to pretend that these phenomena will stop in the next decades, not to say that our civilization will "repair" the results of its mistakes.

Many of these debates, however, are carried out as if we were in an "ideal" world where it would be enough to say something to see it happen. In the just recent years, many members of our societies (who were still, several decades ago, treating those of us who were announcing massive extinctions, of birds of ill omen or simply of liers) have progressively become conscious that our civilization is indeed destroying a large proportion of the species biodiversity of our planet. This is a nice step, but as long as it is not followed by major changes in major options of our world, regarding industry, economics, profit and decision-making, this consciousness-raising will have little material impact. Words won't replace action in this respect, and as long as our societies do not make these major changes, extinctions will go on. Saying and writing the contrary is lying to the public. And it is a lie to say that we will "repair" the damages we have done.

Promoting the idea that collecting *one specimen* for the taxonomic and nomenclatural purpose to have an onomatophore, i.e., a testimony of the existence of a species for present and future researchers, is a major factor of species extinction, is an hypocrisy and a lie. It does not help "conservation biology" to reach any of its aims — but it may appear easier and less costly to pretend so than to struggle against industrial lobbies or shareholders of companies responsible of the current disaster. Taxonomists should resist this pressure, and organize themselves for this resistance.

Today, "conservation" appears to many as a more laudable aim than "knowledge". However, one of the major aims of science, besides helping man to act efficiently in mastering the causes and effects, is "simply" to "understand" the world we live in. One of the major aims of comparative (i.e., non-reductionist) biology is to understand how evolution has proceeded, and to reply these "how" and "why" questions it is first necessary to reply "what" questions (Mayr 1997). With less, or possibly much less, than 10 % of the living species of our planet yet collected, described and named, we cannot say that we are close to answering the "what" questions of biodiversity (Dubois submitted-a) — which means that we are still far from being able to answer the "how" and "why" questions. Isn't it legitimate to think that answering these questions should remain a major goal of science and culture?

The gigantic recent progresses in molecular study of organisms, especially through the use of nucleic acid sequencing for molecular phylogeny, have tended to obscure the nature of biodiversity for many zoologists, some of whom have no or almost no "culture" in morphology, anatomy, behaviour, etc. As interesting as knowing the DNA sequences of an organism may be, these won't tell us everything about the organism. Until the phenotype, behaviour, ecology, of a species have been studied, we know almost nothing about this species, even if we have an hypothesis on its phylogenetic position and if we are able to "recognize" it by its DNA

sequence. Fortunately, in front of those who think that everything about organisms can be known from their DNA and photographs, the irreplaceable rôle of vouchers and specimen collections in systematics, and more generally in all works on biodiversity, has been outlined repeatedly by workers in botany (Funk *et al.* 2005), herpetology (Stuebing 1998), ornithology (Goodman & Lanyon 1994, Remsen 1995, Winker 1996) and mammalogy (Patterson 2002).

The contribution of a specimen to our knowledge about biodiversity is roughly inversely proportional to its rarity. Several steps can be distinguished in our knowledge of a species through specimens. The first one is passing from *no* specimen to *one* specimen. The second one is passing from one to several from the same population, especially to a second one of the opposite sex. A third step can be recognized when small series of specimens, e.g., of 8–20 specimens of each sex from a population, are available, as these allow simple statistical tests for comparisons of samples (Dubois 1984), and a fourth step is attained when samples from several populations referred to the same species have been collected. Among these steps, the one which is by far the main one, for our knowledge, is the first one. The number of characters that can be studied on a specimen is virtually endless (Dubois & Ohler 1997a), and a single holotype allows innumerable observations, especially when non-intrusive techniques such as radiograph or scanner are used. But lacking a holotype, even when DNA or photographs are available, precludes a number of studies.

Recent trends for opposition to collecting specimens are, at least, in the eyes of taxonomists and evolutionary biologists, based on a ill-understood approach to "ethics", chosing ignorance in the name of "conservation", although it is clear that efficient conservation cannot be based on ignorance. This was a rarity a few years ago, when a student in a field research party could decide to release at night a specimen of a new species of salamander kept alive in a plastic bag (David Wake, personal communication to AD, about the specimen of the new species *Bolitoglossa jacksoni* shown in fig. 6 of the paper by Elias 1984). Nowadays, when finding a unique specimen of a lizard species considered extinct and rediscovered after 130 years, even a professional zoologist may decide to photograph and release it (Ineich 2006): what could have been in a rather recent past considered a professional misconduct is now more or less imposed by the "ethically correct" tyranny. This is part of a more general trend in which some students may now embark on higher studies in biology but refuse to kill specimens or to experiment on them. If this trend goes on, zoologists may be forbidden to collect specimens even in order to photograph them or take a feather or a drop of blood from them, in order not to "disturb" them. This would indeed remind the obscurantist medieval times when anatomists and physicians would be forced to dungeon or to stake for having dissected human bodies.

Winker (1996) identified five causes for the opposition to collecting specimens for biodiversity studies: (1) focusing conservation at the level of the individual; (2) unfamiliarity with population biology; (3) misunderstanding of scientific research; (4) typological thinking; and (5) misplaced morality. Except for (4), all these factors are active in the opposition to collection and fixation of even a single specimen as holotype for a new species, and should be countered by taxonomists.

When Vieilliard (1976) described the new Kabyle bird species *Sitta ledanti*, he collected, killed and fixed one adult male for holotype and one adult female for paratype, although he was then aware of the existence of only a dozen of couples. No doubt if an ornithologist was doing this today, he would face difficult time with "conservation biologists". Nowadays, although still threatened, this species is still alive and other populations have been discovered (Bellatreche 1991, Doumandji & Kisserli 1993). However, the important point regarding the present discussion is that, if unfortunately this species had become extinct, the existence of one specimen of each sex in a museum collection was liable to provide major information on its morphology and anatomy which descriptions and illustrations alone could not provide. Taxonomists should care for obtaining such basic, "minimum" material, for all new species they discover and will discover in the coming years and decades.

The media and laymen are very excited everytime a new fossil species of dinosaur or humanoid, or a large species of living mammal or bird, is discovered, but interest is much weaker for less "extraordinary" discoveries, especially of organisms smaller, more discrete, or less close to our own species. Zoologists and especially taxonomists are not bound to share this approach, and may feel that any obscure mite or sea snail is as impor-

tant to knowledge as a dinosaur. One way of making sure that discoveries of new species are transmitted to our descendants is not only to describe them but to keep voucher specimens in museums and other permanent collections. Nomenclatural Rules, in obliging serious taxonomists to keep at least one specimen of each described species, are a strong support for such an activity. The progress made in Article 16 of the last version of the *Code* should be made more irreversible by making this article more stringent. The need of depositing an onomatophore in a permanent public collection should be recognized for standard publications of species. However, some of the problems mentioned above should also be addressed. We therefore provide below some suggestions and recommendations in this respect for the future.

Proposals regarding the Rules of nomenclatural availability of nomina

Biology needs a universal and unambiguous language for the designation of taxa, and this language is provided by the codes of nomenclature. For a smooth and efficient functioning of these codes, some principles must be respected (Dubois 2005: 375–378). An important principle is simplicity, especially the fact that Rules are unique and general and contain as few exceptions and special situations as possible. In zoology, the current *Code* contains already too many exceptions and particular cases (especially Rules that are valid only until a certain date, or after a certain date), and if it was to be changed in this respect, this should be in the sense of simplification and uniformisation, i.e., of suppression of exceptions and particular cases. It would therefore not be appropriate to consider the introduction of special Rules for the availability of nomina, e.g., for "very endangered species", for "very rare species", for "species difficult to collect" or for "extinct species known only from iconographic documents". The same Rules should apply to all animal taxa, whether large or endangered, rare or common, living or extinct. However, there should be room within these Rules to deal appropriately with all specific cases and situations.

In our opinion, Article 16 should be made more stringent regarding the need of onomatophore deposition. We think the major strength of the *Code*, and its superiority over alternative nomenclatural systems that have been proposed, lies in its being based on onomatophores for allocation of nomina to taxa: this establishes a connexion between the world of organisms and that of language, and allows this allocation to be objective, not based on interpretations of definitions. We think the need of material onomatophores (i.e., specimens, not photographs, sound recordings or molecular sequences) for the availability (and hence validity) of zoological nomina should now become even more stringent than in the past. This would insure not only to maintain this objective reference for ascertaining the status of nomina, but also to make sure that at least one specimen of every new species described in this century will be the matter of a legacy to our descendants. This does not mean however that collection of specimens should be made blindly and without care for problems of species conservation. Regarding the latter problems, we think two different approaches should be combined: (1) the careful choice of specimens collected and fixed; (2) in some cases, the recourse to alternative approaches, i.e., delaying naming or naming through a specific action of the Commission.

The first way to conciliate the concerns for conservation issues with a *Code* requiring that at least one specimen should be held and conserved in trust for science, is through the choice of this specimen. In most cases, especially involving vertebrates, a male (preferably an older one, which has greater probability of having reproduced and of not being able to do it again) should be preferably kept instead of a female, due to the potential lower impact on the effective number of the population. In some other cases, when the sex ratio is particularly skewed, the specimen should be taken among the most abundant sex, and if several widely different phenotypes are observed, the most common one should be chosen.

Now, we have seen above that, in some cases, it is indeed useful to have the possibility to describe a new species without having a specimen in hand. It might indeed be the case in some exceptional cases (although not as a routine procedure) for species threatened with extinction but which might still survive if we do not fix

a single specimen (e.g., a species for which only one couple would still be alive). It might be the case for some species which are indeed (at least for the time being) impossible to collect or to conserve. Above all, it has been and will certainly again be the case for species that are now (or are now believed to be) extinct, but for which illustrations or descriptions are available and informative enough to allow the proper description and naming of a new taxon.

In such cases, two different situations must be distinguished. In the first one, the possibility exists to obtain later a specimen that could be deposited in a collection as onomatophore. This may be after more precise estimates of the number of alive specimens of the species have been obtained, ascertaining that they are more numerous than initially thought, and allowing to collect one of them. This may be after recovery of an initially very low population, with increase in its size. This may be after discovery of other populations of the same species. This may be after permanent close watch of the relict population, allowing to collect one specimen after its natural death. This may be after techniques have been developed allowing to capture a specimen although this had long been considered impossible (as in the case of *Torquerator bullocki* mentioned above). In all these cases, it is certainly much better to wait for formally describing the new species until a specimen has been collected and studied. This would avoid basic factual mistakes based on wrong interpretations of photographs as in the example of *Torquerator bullocki*. This course is the one that had been suggested by Timm *et al.* (2005) in the case of the monkey *Lophocebus kipunji*: "Jones and colleagues are encouraged to acquire a specimen, or part(s) thereof, and prepare a new description of this, as yet, undescribed species".

This course raises only one problem, but a genuine one: the risk that (an)other author(s) than the discoverer(s) of the species take advantage of this absence of formal description to collect a specimen, describe and name it to become "author(s)" of the new nomen. Although this is not much mentioned in textbooks, the history of zootaxonomy is full of similar examples, which indeed are a major plague of the discipline, as is well known by all researchers in this field. Interestingly, in the many discussions that have been devoted in the recent years to proposals of changes or improvements that should be brought to the current nomenclatural Rules, few discussed this problem. As was very aptly pointed out by Ng (1994), the function of adding the name of the author after the nomen of a taxon is not to please the author, "to promote the reputation of a scientist or simply an egotistical exercise", but is to help "to keep track of authors, publication dates and to trace the original references", through databases like the *Zoological Record*. Dubois (2000) discussed this matter and suggested that mentioning only the publication year of the nomen, without the author(s)' names, would play the same function and would help limiting artificial inflation of unwarranted nomina provoked mostly by "mihilism", as Bruun (1950) ironically termed it. However, such a change would clearly threaten the egos of so many taxonomists that, although it may be highly desirable (Dubois submitted-b), it may not be easy to implement, as highlighted by the fact that promoters of the *Phylocode* project, who could well have decided not to add authors' names after their nomina, did not apparently consider doing so (Dubois 2005).

A second situation is that of species described on the basis of documents attesting the past existence of a taxon that is now extinct and for which it is unlikely that fossil or subfossil material will be discovered. Such unlikely events sometimes occur, as shown above by the case of the Mascarene turtle. A recent example is quite enlightening: Oliveira & Langguth (2006) elegantly showed that the new monkey species described as *Cebus queirozi* by Mendes Pontes *et al.* (2006) had already been described more than two centuries ago as *Simia flavia* Schreber, 1774. However, such rediscoveries are exceptions and in most cases the species will remain known only from the ancient documents and no specimen will ever be found. In such cases, it would not be clever to impede their formal description and naming because of rigid nomenclatural Rules. So a special solution must be found for such cases.

As mentioned above, there should be a single *Code*, not different Rules for different situations. We think the *Code* already contains a provision that would allow the description of new taxa, in some very exceptional cases, without material onomatophores. Article 10.1 of the current *Code* reads as follows:

"10.1. **General conditions to be met.** A name or nomenclatural act is available, and takes authorship and

date, only when it has satisfied the provisions of this Article and, when relevant, of Articles 11 to 20 (...). A name may be ruled to be available by the Commission (…) if these conditions are not fully met."

We think advantage should be taken of the last sentence of this article to solve the nomenclatural problem here addressed. In the exceptional cases where good reasons (as discussed above) would make it impossible to validly name a new taxon under the usual Rules of the *Code*, this could be done through submitting a special request to the Commission. This could take the form of submission of a manuscript for publication in the *Bulletin of Zoological Nomenclature*, the official journal of the Commission, followed by a vote of the latter to validate the new nomen (just like in the cases of normal applications submitted to the Commission for decision). This would be a heavy procedure, but one which would respect the current Rules of the *Code*. It should remain heavy in order to discourage "lazy" zootaxonomists to call upon it, as it should be used exceptionally, and not become a routine procedure. If nothing is done in this direction, it is not unlikely that in the coming decades all new species of primates, why not of mammals, why not of vertebrates, will be described on the basis of photographs or of DNA sequences taken from a hair, a feather or a drop of blood, without even a brief description of the organism, and without material onomatophores. For the reasons explained above, such a move would be very harmful to taxonomy in the future.

Conclusion

Voucher specimens play a crucial, although often misunderstood, role in modern taxonomic and evolutionary research. Among them, onomatophores ("name-bearing types") play a special function, being the objective references for the allocation of nomina to taxa. The Rules of the *Code*, which have been improved in the last edition in making compulsory the designation of a material onomatophore (one specimen or several specimens) for the availability of a new nomen, should also make compulsory the deposition of onomatophores in public collections. In the few exceptional cases where collection or conservation of a specimen is impossible (for difficulties of collecting or of keeping, for conservation reasons, or when the taxon is known only from ancient documents), choice should be made between two possible courses: (1) either preliminary description of the taxon through indirect evidence (photographs, DNA sequence, etc.), but without naming it, pending the acquisition of an onomatophore and its deposition in a public collection, whenever this subsequent acquisition is likely; (2) or formal description of the taxon and proposal of a new Latin nomen based only on photographs, drawings, DNA sequence or other indirect evidence, but then in a paper submitted for publication in the *Bulletin of Zoological Nomenclature*, followed by a vote of the Commission to validate nomenclatural availability of this new nomen under the provision of the last sentence of Article 10.1.

For implementation of these changes in the *Code*, we propose the following new wording for Article 16.4 (no changes are proposed in the four recommendations of this article):

"16.4 **Species-group names: explicit fixation and deposition in public collections of name-bearing types.** Every new specific and subspecific name published after 1999, except a new replacement name (a nomen novum), for which the name-bearing type of the nominal taxon it denotes is fixed automatically (...), must be accompanied in the original publication

16.4.1. by the explicit fixation of a holotype, or syntypes, for the nominal taxon (...), and,

16.4.2 by its deposition in a collection or several, with a statement indicating the name and location of this (or these) collection(s), or a statement that it or they will later be deposited there (see Recommendation 16C).

16.4.3. In the exceptional case where the holotype or syntypes cannot be collected and/or conserved (because the taxon is believed to be extinct, of difficulties or impossibilities of specimen collection or conservation, or because the taxon is threatened with extinction), formal description and naming of the taxon should be postponed until one or several specimens can be collected; if it is unlikely that any specimen will ever be available for deposition in a collection, the taxon should be described and named on the basis of indirect evi-

dence (e.g., ancient document showing an illustration or presenting a description of the taxon, photograph, molecular data) in a paper submitted for publication in the *Bulletin of Zoological Nomenclature*, and formal availability of this name should be voted upon by the Commission as allowed by Article 10.1."

To complete this change in Article 16, the following new wording should be implemented in Article 73.1.4:

"73.1.4. Designation before 2000 of an illustration of a single specimen as a holotype is to be treated as designation of the specimen illustrated; the fact that the specimen no longer exists or cannot be traced does not of itself invalidate the designation. (...)

We believe these proposed changes in the *Code* would allow to solve the problem raised in recent papers, regarding the description and naming of new species without contributing to their extinction, but without opening the door for a routine description of new species without onomatophores, which would be very detrimental to taxonomy and to our knowledge of biodiversity.

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